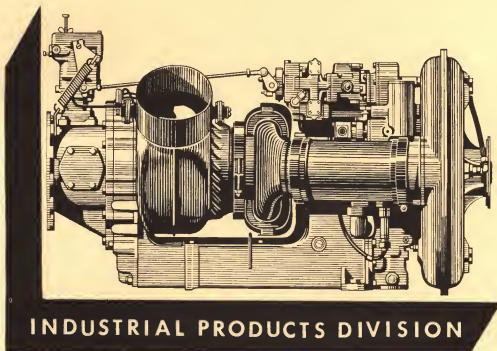


MODEL SPECIFICATION

BOEING 502-10MA

GAS-TURBINE ENGINE



INDUSTRIAL PRODUCTS DIVISION

D4-1376



BOEING MODEL 502-IOMA GAS-TURBINE ENGINE

Date: September 11, 1959

Revised: October 28, 1959

Revised: January 11, 1960

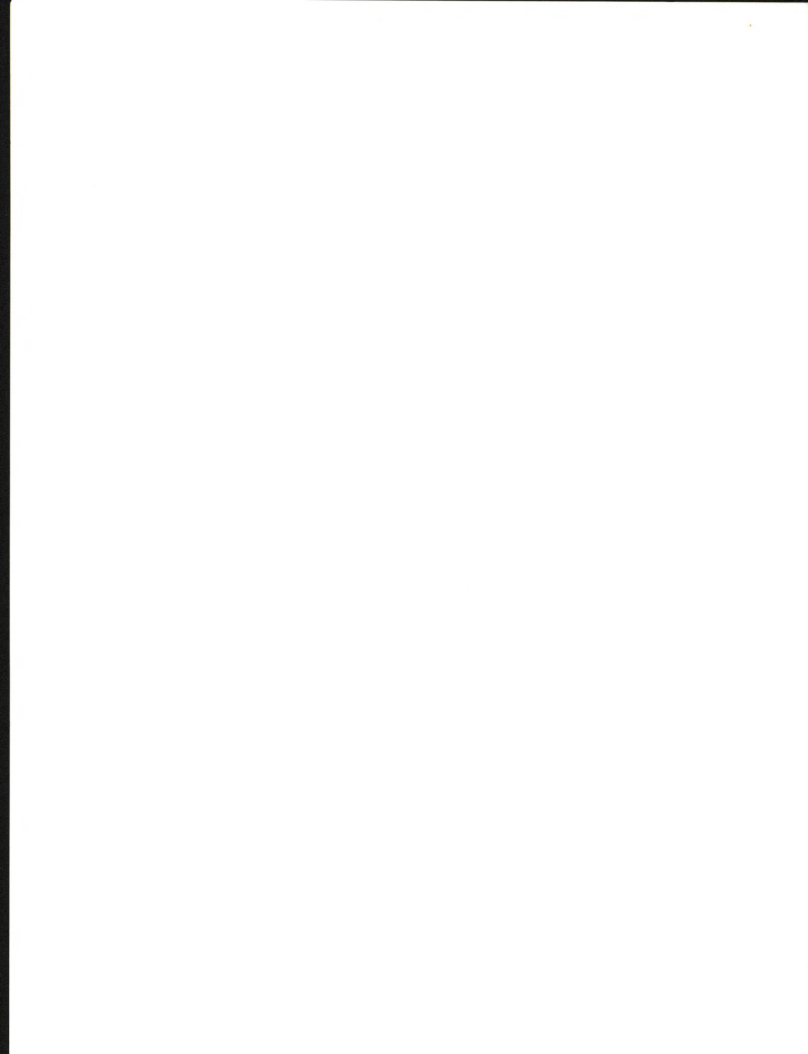
Revised: June 1, 1960

Revised: May 22, 1962

Revised: January 14, 1963

**INDUSTRIAL PRODUCTS DIVISION
BOEING AIRPLANE COMPANY**

D4-1376



MODEL SPECIFICATIONS
BOEING MODEL 502-10MA GAS-TURBINE ENGINE

I. DESCRIPTION

The Boeing Model 502-10MA gas turbine is a further development of the Model 502-10C, retaining the basic mechanical configuration of the latter. Primary changes to achieve increased power and reduced fuel consumption are a new compressor design and improved materials in engine hot components. The engine consists of two major sections: a gas-producer and a power-output section. The gas producer contains a single-entry centrifugal compressor coupled to a single-stage axial-flow turbine, two cross-connected combustion chambers of the through-flow type, and an accessory-drive section. The power-output section incorporates a second axial-flow turbine, reduction gearing, and a flanged output shaft. The reduction gear housing is also flanged to allow direct attachment to a stationary housing. There is no mechanical coupling between the turbine rotors of the gas-producer and power-output sections. This arrangement permits the gas-producer speed and engine power to be controlled independently of the output-shaft speed, resulting in an engine with output speed variable from 0 to 110 per cent of rated rpm for either full-or part-throttle operation. Continuous operation near the stalled output shaft condition does not over-heat the engine. Figure 2 illustrates the advantages of this characteristic for starting under load and operating without a clutch.

Boeing Airplane Company installation drawing 45-2157 forms part of this specification.

II. PERFORMANCE

| TABLE I Standard Conditions 80°F. 29.92 in. Hg | | | | | |
|---|-----|-------------------------------|---------------------------------|-----------------------------------|------------------------------|
| Rating | BHP | Gas- Producer RPM (Max) | Optimum Output Shaft RPM* | Exhaust- Gas Temp. °F (Max) | SFC LB/HP/HR (Nominal) |
| Maximum Intermittent | 300 | 39,000 | 3400 | 1215 | .94 |
| Normal Continuous | 270 | 38,500 | 3300 | 1180 | .97 |

*Output shaft RPM is shown with the standard reduction gear ratio of 8.9:1

| TABLE II Standard Conditions 60°F 29.92 in. Hg | | | | | |
|---|-----|-------------------------------|---------------------------------|-----------------------------------|------------------------------|
| Rating | BHP | Gas- Producer RPM (Max) | Optimum Output Shaft RPM* | Exhaust- Gas Temp. °F (Max) | SFC LB/HP/HR (Nominal) |
| Maximum Intermittent | 330 | 39,000 | 3400 | 1200 | .92 |
| Normal Continuous | 300 | 38,500 | 3300 | 1170 | .94 |

*Output shaft RPM is shown with the standard reduction gear ratio of 8.9:1

Estimated performance other than full throttle and/or full speed shown on performance curves included in this document.

Unless otherwise specified in the purchase order, the governor throttle stop will be set on all engines before delivery to provide Normal Continuous power at rated output shaft speed, corrected to standard ambient conditions as listed in Tables I and II above. This is the only performance warranty expressed or implied and is the basis of engine acceptance test limits.

III. STANDARD EQUIPMENT AND ACCESSORIES

The following equipment and accessories will be supplied with the engine as standard equipment:

1. Fuel pump and governor unit with acceleration limiter
2. Oil pumps, 1st and 2nd stage
3. Ignition coil and ignitor plugs with suitable leads (without radio shielding)
4. Single-outlet exhaust collector
5. Oil filter
6. 24-volt, 30-ampere starter-generator unit
7. Exhaust gas thermocouples
8. Starter relay
9. Start control and instrument panel including exhaust temperature gage, lube oil pressure gage, start button, and master switch.
10. Rubber engine mounts:
Provision has been made for four point mounting with rubber bushings. Two such mounts at the compressor end of the engine are standard equipment. The two mount brackets and rubber bushings for the reduction gear end of the engine can be furnished on request at extra cost. On most installations the engine is direct connected to a reverse gear, transmission, or generator on which mount pads are provided, in which case the mounts on the engine reduction gear are not needed.
11. Operating manual

IV. OPTIONAL EQUIPMENT AT EXTRA COST

The following accessories are optional equipment furnished at extra cost. Other equipment can be made available by special order for special installations.

1. Compressor inlet silencer and clamp (13 lbs)
2. Air inlet bell and clamp (3.5 lbs)
3. Tachometer indicator and mechanical tachometer drive for gas producer section. (1.5 lb)
4. Tachometer sending switch and indicator for power output section, includes one drive pad as listed under item 5 below. (3 lbs)

5. Accessory drive assembly on power output section (engine will accommodate three but one is normally used for driving second stage oil pump and is standard equipment) (2.5 lbs each)
6. 30-ampere 24-volt negative ground voltage regulator (3 lbs)
7. Reduction gear ratio of 5.04:1
8. Reduction gear ratio of 10.9:1
9. Oil temperature thermocouple and indicator for installation in oil line from oil cooler to engine. Oil sump thermocouple can also be furnished on request. (1.5 lbs)
10. Fuel filters (one each metal edge and micronic types included)
11. Double outlet exhaust collector
12. Oil cooler
13. Fuel boost pump
14. Power section governor for variable output speed (includes governor, control linkage, and one each Item 5) (6.0 lbs)
15. Speed topping governor for power output section (includes governor, control linkage, and one each Item 5)

V. ACCESSORY DRIVES ON GAS PRODUCER SECTION

| Accessory Drive | Mounting Pad | Ratio to Compressor RPM | Rotation Looking at Pad | Max. Cont. Torque lb-in. | Max. Static Torque lb-in. |
|-------------------------|--------------|-------------------------|-------------------------|--------------------------|---------------------------|
| Starter Generator | *Special | 0.279:1 | Counter-Clockwise | 177 | 797 |
| Tachometer (Electrical) | AND20005 | 0.100:1 | Counter-Clockwise | 7 | 50 |
| Pump Governor | *Special | | Clockwise | 47 | 244 |
| Oil Pump | Special | 0.100:1 | Clockwise | 17 | 107 |

*Drive gear mounted on accessory

VI. ACCESSORY DRIVES ON POWER OUTPUT SECTION

The power-output section has provision for the following accessory drives:

| Accessory Drive ① | Mounting Pad | Ratio to Output-Shaft RPM | Rotation Looking at Pad | Max. Cont. Torque lb-in. | Max. Static Torque lb-in. |
|---------------------------|--------------|---------------------------|-------------------------|--------------------------|---------------------------|
| Tachometer (Electrical) ② | AND20005 | 1.00:1 | Clockwise | 50 | 225 |
| Spares 1 (or 2) | AND20000 | 1.00:1 | Clockwise | 135 | 400 |

① May be converted to AND20000 by removal of internal spline adapter

② A second AND20000 accessory drive can be provided.

When these drive assemblies are not specified, cover plates will be installed. Locations of these accessory drives may be interchanged among the three positions provided on the gear housing. (Reference Boeing Airplane Company installation drawing 45-2157.)

VII. ENGINE WEIGHT

The dry weight of the engine with standard equipment and accessories as noted on page 3 is 335 pounds. Weights of optional equipment are indicated on page 3 and 4.

VIII. FUEL SYSTEM

The Boeing Model 502-10MA engine has been developed to operate on a number of fuels, including diesel oil, jet engine fuel, and kerosene, without changes to the fuel system. Unless otherwise specified, the engine will be adjusted and acceptance-tested using diesel oil conforming to Specification MIL-F-896, or commercial diesel fuel of equivalent quality. Special operating precautions are necessary when operating in multi-fuel service, and instructions should be obtained from Boeing Airplane Company.

- A. Fuel is supplied under pressure to the burner nozzles by the engine-driven fuel pump and governor unit which provides speed control of the gas producer. An acceleration limiter, which controls fuel flow to the engine during rapid movement of the throttle, limits the rate of acceleration of the gas producer from idle to maximum speed and is supplied as an integral part of the fuel pump and governor.

- B. The engine-driven fuel pump has provision for attaching a 3/8 inch-diameter fuel-supply line.
- C. Fuel-nozzle pressure normally will vary from approximately 30 psi at idle to approximately 250 psi at maximum rated engine speed.
- D. Electrically operated shutoff valves are provided as part of the fuel system. These valves are used during engine starting and shutdown, and a suitable control switch for operation from the control panel is required.
- E. Fuel must be supplied to the inlet of the engine-driven fuel pump at a pressure of 30 psig and fuel flow of 2 gpm with contamination not to exceed that which will pass through a 40 micron filter.
- F. Provisions should be made for fuel return from the fuel pump and governor unit to the tank.

IX. IGNITION SYSTEM

- A. The electrical system of the engine is designed for a negative ground circuit.
- B. The ignition system consists of a capacitance-discharge ignition unit and two vaporizing-type spark plugs with suitable leads.
- C. The ignition wiring is connected in parallel with the starter circuit, since operation of the ignition system is required only during starting.

X. LUBRICATION SYSTEM

The complete lubrication system is integral with the engine except for the oil cooler. The oil sump is part of the gas-producer section and has a capacity of 6 U. S. quarts. Two double element pumps, one on the first stage and one on the second stage, supply oil under pressure via a full-flow micronic filter to the bearings and gears. Either or both pumps scavenge the oil in the power-output section.

- A. Normal oil consumption is estimated to be less than 1 quart in 15 hours of operation. A bayonet-type gage is included with the engine and is graduated to indicate FULL when the sump contains 6 quarts and the engine is level. Minimum oil pressure allowable at rated speed is 20 psig. Oil pressure normally will vary from 30 to 40 psi at rated speed to 10 psi at idle. A fitting for a 1/4-inch-diameter gage line is provided in the engine pressure system. An oil drain plug is located at the bottom of the oil sump.

- B. Lubricating oil for use at ambient temperatures above 0°F shall be SAE 10 conforming to Specification MIL-O-2104. Use of other oils, including oil for use at ambient temperatures below 0°F, should be coordinated with the Boeing Airplane Company.
- C. A thermocouple should be installed in the oil line out of the oil cooler to the engine. The temperature of the oil to the engine should never exceed 220°F. During normal operation this temperature should range from 120° to 180°F. The heat rejection to the oil at normal rated power is estimated to be not more than 1100 BTU per minute. An oil cooler must be provided in the oil-supply system. Oil supply ports to and from the cooler are provided for on the engine as shown in installation drawing 45-2157. The type and size of oil cooler will depend on the particular installation. Recommendations for the oil cooler will be given by the Boeing Airplane Company after a study of the proposed installation.

XI. INSTALLATION

A. Mounting

Provisions for mounting the engine are as shown on Boeing Drawing 45-2157. The engine mounts located on the power-output section are not used when the engine is directly bolted to a gearbox through the gearbox mounting flange.

B. Dimensions

For basic engine dimensions and the location of the center of gravity, see Boeing Airplane Company installation drawing 45-2157.

C. Engine Attitude

The engine has been designed to operate satisfactorily when permanently pitched 15° or rolled 30°. Momentary pitching up to 30° or rolling up to 45° is permissible.

D. Engine Compartment Ventilation

Installation of the engine will require a positive flow of cooling air over the engine to carry heat from the nozzle box and exhaust ducts away from the gas-producer accessory section. Under normal operating conditions the average skin temperature of the nozzle box is approximately 1300°F, and that of the exhaust ducts is approximately 500°F. No insulation should be used on the nozzle box. A ventilating air flow of 1000 cfm at sea level is required to prevent overheating of these parts. It is necessary to use a baffle or other arrangement behind the inlet bell or silencer to prevent hot air from entering the compressor inlet. Considerable loss of power can result from allowing heated air to enter the compressor inlet.

E. Output Shaft

1. A 4.50-inch diameter output shaft flange is provided, having a 2.00-inch-diameter female pilot and six 3/8-inch-diameter holes on a 3.75-inch-diameter bolt circle.
2. Shaft rotation is counterclockwise when viewed from the power-output end of the engine.

F. Polar Moments of Inertia

The polar moments of inertia of the rotating masses of the engine are approximately as follows:

1. Gas-producer-rotor assembly (0.20 lb-in-sec²)
2. Power-section rotor assembly (0.20 lb-in-sec²)

NOTE

For polar moment of inertia of the power output section at the output flange, multiply 0.20 lb. in sec² by the square of the reduction ratio.

Example: $0.20 \times 8.90^2 = 15.85 \text{ lb-in-sec}^2$

G. Nozzle-Box Fuel Drain

A 1/8-inch pipe-threaded boss restricted to a 3/32-inch opening is provided at both the top and bottom of the nozzle box. The bottom fitting serves as an excess-fuel drain and should be left open. This fitting is provided with a drain tube. The top boss may be used to measure nozzle-box pressure in performance checks.

H. Design Changes

Boeing Airplane Company reserves the right to make design changes. Efforts will be made to coordinate these changes where installation or operation may be affected.

XII. INSPECTION AND TESTS

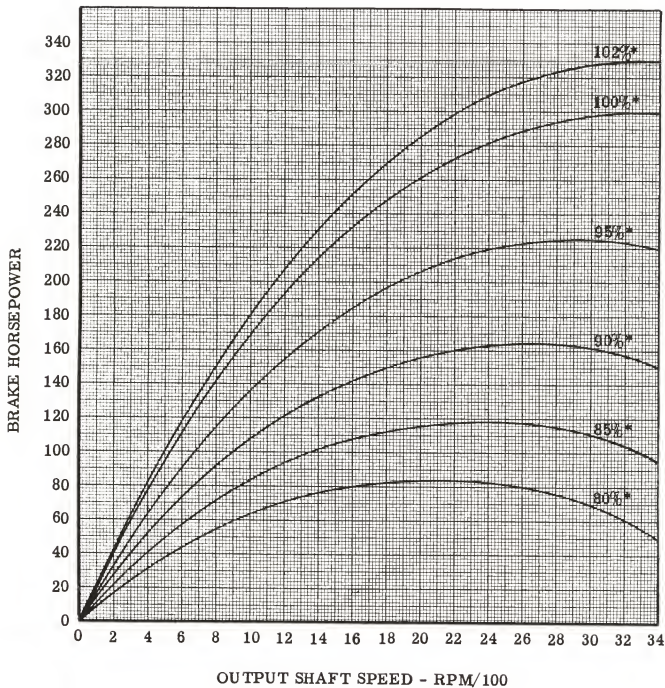
Testing performed by Boeing will be only that required to insure proper performance of the units before delivery. These tests will include acceptance tests in accordance with established Boeing Airplane Company standards and engine performance calibration.

XIII. PACKAGING & PACKING

Packing for shipment will be performed by the Contractor in such a manner as to insure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery unless otherwise mutually agreed.

BRAKE HORSEPOWER
ESTIMATED PERFORMANCE

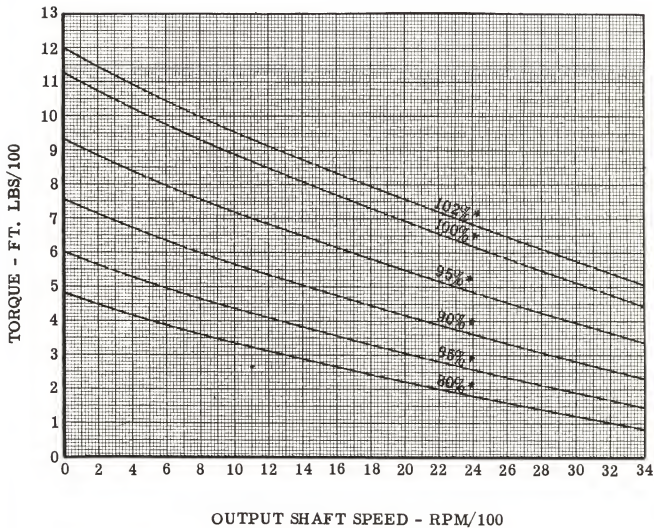
AMBIENT CONDITIONS: 60°F, 29.92 In. Hg.



*PER CENT OF NORMAL RATED GAS PRODUCER SPEED

OUTPUT TORQUE
ESTIMATED PERFORMANCE

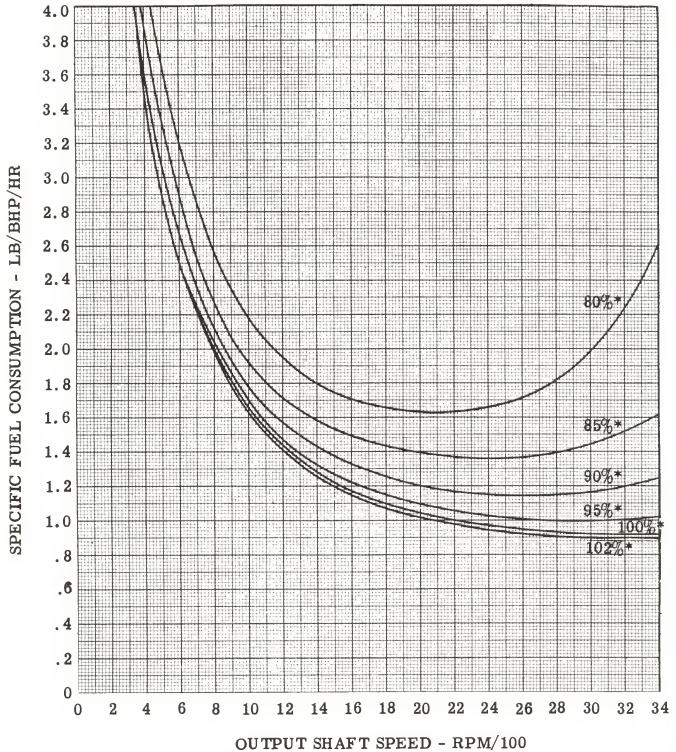
AMBIENT CONDITIONS: 60°F, 29.92 In. Hg.



*PER CENT OF NORMAL RATED GAS PRODUCER SPEED

SPECIFIC FUEL CONSUMPTION
ESTIMATED PERFORMANCE

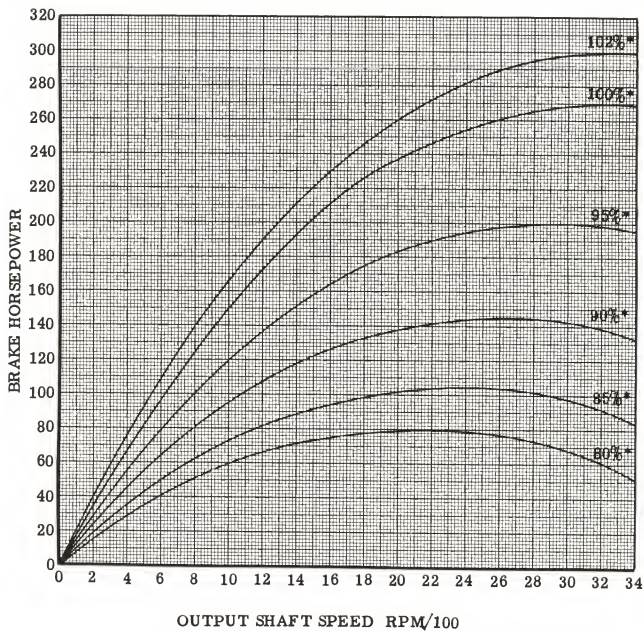
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*PER CENT OF NORMAL RATED GAS PRODUCER SPEED

BRAKE HORSEPOWER ESTIMATED PERFORMANCE

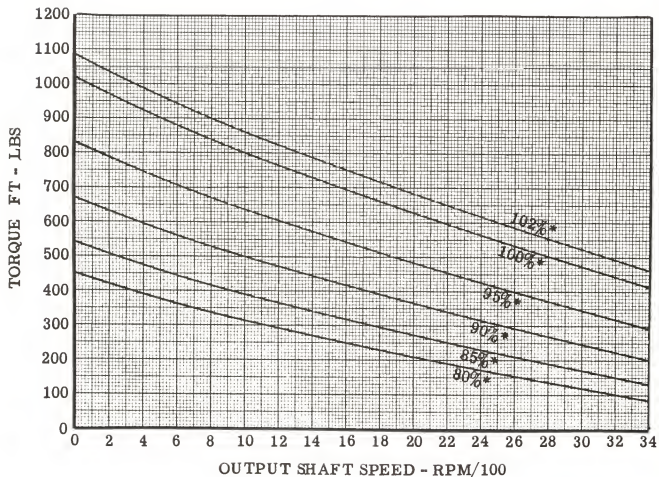
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*PER CENT OF NORMAL RATED GAS PRODUCER SPEED

OUTPUT TORQUE
ESTIMATED PERFORMANCE

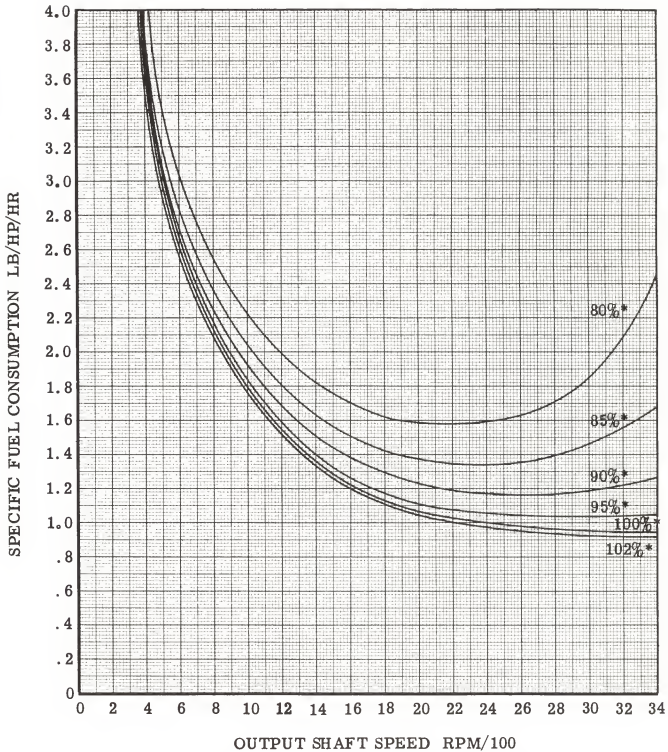
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*PER CENT OF NORMAL RATED GAS PRODUCER SPEED

SPECIFIC FUEL CONSUMPTION ESTIMATED PERFORMANCE

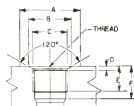
AMBIENT CONDITIONS : 80°F, 29.92 In. Hg.



*PER CENT OF NORMAL RATED GAS PRODUCER SPEED

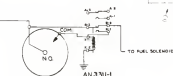
- 1 TACHOMETER GENERATOR
- 2 FUEL INLET (SEE AND10050-6)
- 3 FUEL PUMP O-RING
- 4 OIL OUTLET TO PRESSURE GAUGE (SEE AND10050-4)
- 5 OIL OUTLET TO COOLER (SEE AND10050-8)
- 6 OIL COOLER RETURN (SEE AND10050-8)
- 7 ENGINE MOUNTS - FRONT
- 8 RECEPTACLE-ELECTRICAL SYSTEM
- 9 STARTER & IGNITION RELAYS
- 10 ENGINE MOUNTS - REAR
- 11 PLUG-ELECTRICAL SYSTEM
- 12 FUEL PUMP & GOVERNOR
- 13 PRESSURE FITTING-NOZZLE BOX (1/2 NPT)

- 15 ENGINE MOUNTING FLANGE-REAR
- 16 OUTPUT SHAFT-FLANGED
- 17 FUEL DRAIN-NOZZLE BOX
- 18 THERMOCOUPLE-LUBE OIL
- 19 OIL DRAIN & SCREEN-MAIN SUMP
- 20 IGNITION UNIT
- 21 OIL FILTER
- 22 IGNITION PLUG
- 23 THERMOCOUPLE RING-EXHAUST GAS
- 24 EXHAUST COLLECTOR-SINGLE OUTLET
- 25 STARTER GENERATOR
- 26 OIL FILLER & BREATHER
- 27 DRAIN-OIL FILTER
- 28 OIL SCREEN OUTPUT SECTION SUMP
- 29 OIL DRAIN OUTPUT SECTION SUMP
- 30 CONTROLLER ASSY AUTOMATIC STARTING
- 31 FUEL DRAIN-SHUT OFF VALVE



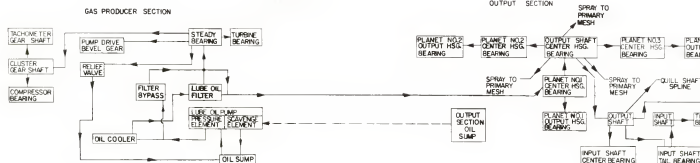
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| 5 | -6 | 3/8-16UNF-38 | 3/8 | .863 | .668 | .580 | .083 | .469 | .594 |
| 6 | -8 | 3/4-16UNF-38 | 1/2 | .868 | .875 | .769 | .094 | .562 | .718 |

+24VDC POWER



OVERSPEED SHUTDOWN SWITCH (SCHEMATIC)

LUBE SYSTEM DIAGRAM (SCHEMATIC)



OIL PRESSURE SENDER

- +24V DC TO STARTER RELAY
- +24VDC TO FUEL SOLENOID
- +24 VDC POWER OUTPUT AMP
- STARTER OFF (2000RPM & UP)
- +24V DC POWER TO FUEL BOOST PUMP (6 AMP)
- +6V DC TO ENGINE OIL PRESSURE SENDER
- +24V DC POWER INPUT
- +24 V DC (GROUND)
- +24 V DC TO IGNITION RELAY
- TO ENGINE TACHOMETER SENDER

AUTOMATIC START CONTROLLER FOR WIRING DIAGRAM SEE SIDING DRAWING 45-1742-7



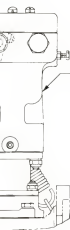


22.50
DIA

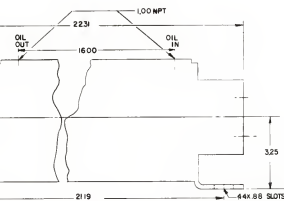
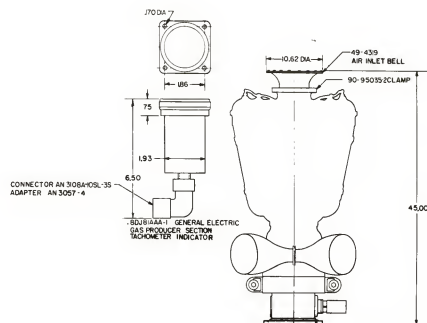
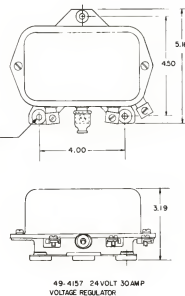
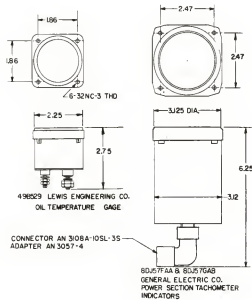
50-95027

INLET AIR
SILENCER

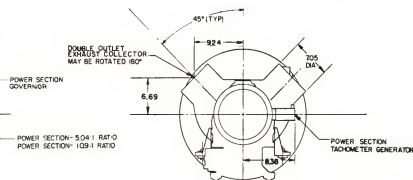
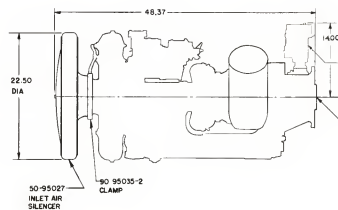
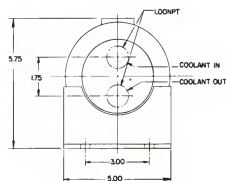
OIL COOLER 8523534
MODEL AP20AUS-01
HARRISON RADIATOR DIV. G M



G414MS
50 TYP. GOVERNOR
(POWER SECTION)



F-302-WY-2 YOUNG RADIATOR CO OIL COOLER



ACCESSORIES SHOWN ON THIS SHEET ARE OPTIONAL
EQUIPMENT. ITEMS IN ARE NOT INCLUDED AS ENGINE
STANDARD EQUIPMENT

